

congestion. Mckinnon (1998) investigated the effects of traffic congestion on business through interviewing 23 managers at seven distribution centers in the fast moving consumer goods (FMCG) sector in the UK. Results show that traffic congestion was inflating the distribution centers' warehousing costs by 20%. The Hague Consulting Group (HCG) (1998) undertook a study of investigating the magnitude and cost of delays to freight traffic in the UK, France, Poland, and the Czech Republic. The research suggests that indirect (off-the-road) costs of congestion to businesses exceed the direct (on-the road) costs. Bozuwa and Hoen (1995) conducted a Dutch study and asked 230 haulers and shippers who regularly used congested sections of motorways to place a monetary value on reliability. Their results suggest that unreliability added 8-11% to the costs of congestion. O'Mahony and Finlay (2004) analyzed data from a survey of 584 companies in Ireland. The survey requested information on company characteristics, whether it transported goods by road, the impact of traffic congestion on businesses, and the coping strategies the companies used to deal with traffic problems. The findings indicated that traffic congestion has an impact on a large portion of companies to a major degree.

The identifiable variation in data, methods and results in the literature suggests the complexity of the problem and shows that there is a need to further explore economic costs of unexpected congestion, especially the costs incurred by the private sector. As Weisbrod et al. (2003) pointed out, "it presents a starting point—showing many facets of congestion impacts on businesses and local economies, illustrating the types of data necessary to document the costs, and demonstrating how analysis can be carried out and ultimately improved".

Incident Management Assistance Patrols

In a pre-cursor study, Khattak et al. (2004) provide a literature review of Freeway Service Patrols (FSP), also referred to as IMAPs in North Carolina. They investigated the value of IMAPs in North Carolina, which help smooth traffic flow by aiding stranded motorists and assisting in incident clearance. Their new approach helps determine the most beneficial locations for patrol deployment using expanded placement criteria in North Carolina. Analysis of three incident/crash indices was combined with spatial analysis, incident type distributions, average hourly freeway traffic volumes, and incident delay estimations to identify, evaluate, and compare FSP/IMAP expansion candidate facilities. Results of the research have been incorporated into a decision-support tool that allows easy planning and operational assessment of candidate sites by comparing performance values between sites, modeling the effect of IMAP and estimating their key potential benefits and associated costs. By using the methodology, NCDOT can quickly assess the needs of different facilities to make an informed, cost-effective decision as to where to implement the next service patrol. There is ample evidence that IMAPs are a cost-effective ITS strategy and that their benefits often exceed the costs, when implemented in the appropriate context (Khattak et al., 2004).

Advanced Traveler Information Systems

In recent decades, ATIS have emerged to support more informed travel decisions. Individuals or commercial users now can receive dynamic information through a variety of sources, e.g., Internet, 511, television, radio, kiosks, and in-vehicle systems. Many studies have pointed out that disseminating real-time traffic information to travelers could offer significant benefits in terms of ameliorating traffic congestion, improving network performance, and enhancing travel safety, thus providing economic and environmental advantages (Ben-Akiva et al., 1991; Khattak et al., 1993; Adler & Blue, 1998). A comprehensive academically-oriented review of advanced traveler